BS EN 12390-7:2019

BSI Standards Publication

Testing hardened concrete

Part 7: Density of hardened concrete

National foreword

This British Standard is the UK implementation of EN 12390-7:2019. It supersedes BS EN 12390-7:2009, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee B/517/1, Concrete production and testing.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

© The British Standards Institution 2019
Published by BSI Standards Limited 2019

ISBN 978 0 580 98438 9

ICS 91.100.30

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 July 2019.

Amendments/corrigenda issued since publication

Date	Text affected

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 12390-7

June 2019

ICS 91.100.30

Supersedes EN 12390-7:2009

English Version

Testing hardened concrete - Part 7: Density of hardened concrete

Essais pour béton durci - Partie 7 : Masse volumique du béton durci

Prüfung von Festbeton - Teil 7: Dichte von Festbeton

This European Standard was approved by CEN on 29 April 2019.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and United Kingdom.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

© 2019 CEN All rights of exploitation in any form and by any means reserved worldwide for CEN national Members.

Ref. No. EN 12390-7:2019 E

Contents

Page

European foreword 3
1 Scope 5
2 Normative references 5
3 Terms and definitions 5
4 Apparatus 5
5 Test specimens 6
6 Procedures 7
6.1 General 7
6.1.1 Determination of mass 7
6.1.2 Determination of volume 7
6.2 Mass of as-received specimen 7
6.3 Mass of water saturated specimen 7
6.4 Mass of oven-dried specimen 7
6.5 Volume obtained by water displacement 7
6.5.1 General 7
6.5.2 Mass in water 8
6.5.3 Mass in air 8
6.5.4 Calculate the volume of the specimen 8
6.6 Volume obtained by measurement 8
6.7 Volume obtained by using designated dimensions (cubes only) 8
7 Test result 9
8 Test report 9
9 Precision 10
Bibliography 11

European foreword

This document (EN 12390-7:2019) has been prepared by Technical Committee CEN/TC 104 “Concrete and related products”, the secretariat of which is held by SN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by December 2019, and conflicting national standards shall be withdrawn at the latest by December 2019.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 12390-7:2009.

This standard is one of a series on testing concrete.

EN 12390, *Testing hardened concrete*, consists of the following parts:

- *Part 1: Shape, dimensions and other requirements of specimens and moulds;*
- *Part 2: Making and curing specimens for strength tests;*
- *Part 3: Compressive strength of test specimens;*
- *Part 4: Compressive strength – Specification for testing machines;*
- *Part 5: Flexural strength of test specimens;*
- *Part 6: Tensile splitting strength of test specimens;*
- *Part 7: Density of hardened concrete;*
- *Part 8: Depth of penetration of water under pressure;*
- *Part 11: Determination of the chloride resistance of concrete, unidirectional diffusion;*
- *Part 12: Determination of the potential carbonation resistance of concrete: Accelerated carbonation method (in preparation);*
- *Part 13: Determination of secant modulus of elasticity in compression;*
- *Part 14: Semi-adiabatic method for the determination of heat released by concrete during its hardening process;*
- *Part 15: Adiabatic method for the determination of heat released by concrete during its hardening process;*
- *Part 16: Determination of the shrinkage of concrete (in preparation);*
- *Part 17: Determination of creep of concrete in compression (in preparation);*
- *Part 18: Determination of the chloride migration coefficient (in preparation).*

This edition includes the following significant technical changes with respect to EN 12390-7:2009:

- editorial revision;
- technical corrections.

According to the CEN-CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

1 Scope

This document specifies a method for determining the density of hardened concrete. It is applicable to lightweight, normal-weight and heavy-weight concrete.

It differentiates between hardened concrete in the following states:

1) as-received;

2) water saturated;

3) oven-dried.

The mass and volume of the specimen of hardened concrete are determined and the density calculated.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 12390-1, *Testing hardened concrete — Part 1: Shape, dimensions and other requirements for specimens and moulds*

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

4 Apparatus

4.1 Callipers and rules, with a maximum permissible error of 0,5 % of the dimension, for measuring the dimensions of the specimens.

4.2 Balance, equipped with a stirrup for weighing the specimen in both air and water with a maximum permissible error of 0,1 g of the mass.

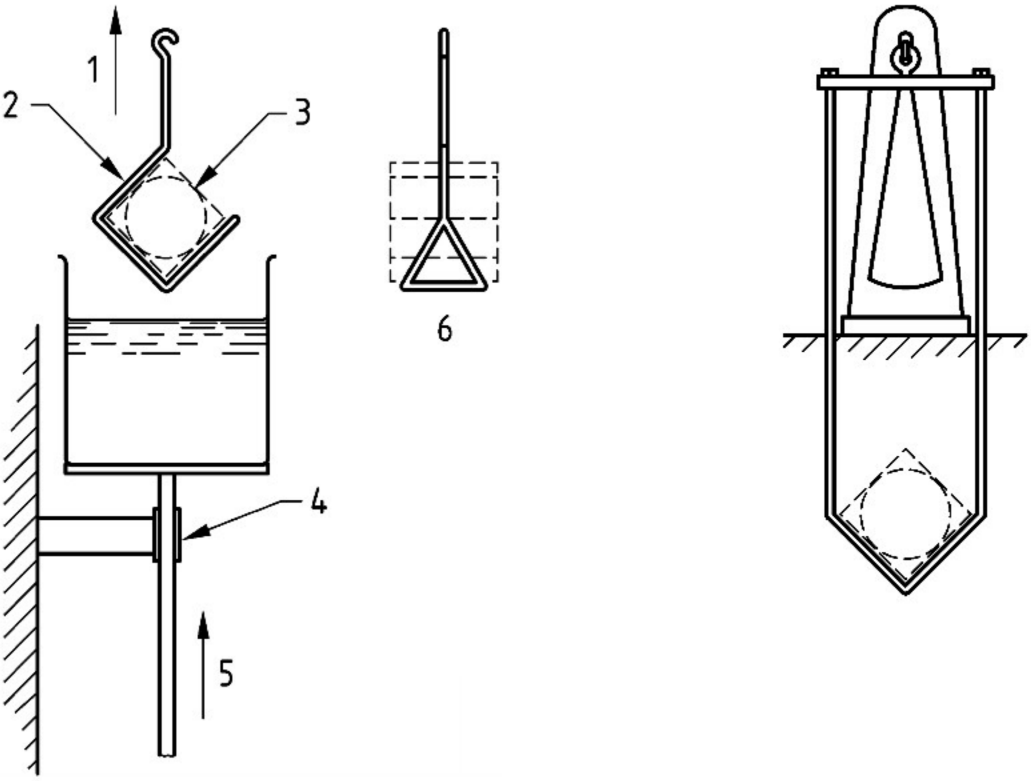
4.3 Water tank, fitted with a device to maintain the water at a constant level and of sufficient size to allow the specimen on the stirrup to be fully immersed to a constant depth (see Figure 1).

If the reading of the balance is affected to within the accuracy required due to the displacement of water when immersing the specimen, then the tank should be fitted with a device to maintain the water at a constant level. The tank should be of sufficient size to allow the specimen to be fully immersed.

4.4 Ventilated oven, in which the temperature is capable of being controlled at (105 ± 5) °C.

NOTE The apparatus required depends upon the method selected for determining the volume of the specimen.

4.5 Moist cloth.



a) Stirrup suspended beneath balance mechanism

b) Alternative form of stirrup suspended beneath balance machanism

Key

1 balance
2 stirrup
3 concrete specimen
4 guide
5 water tank is moved vertically
6 side view of stirrup

Figure 1 — Typical stirrup arrangement for the determination of the volume of concrete specimens by water displacement

5 Test specimens

The minimum volume of a specimen shall be 0,785 l. If the declared value of D of the coarsest fraction of aggregates actually used in the concrete (D_{max}) exceeds 25 mm, the minimum volume (in mm^3) shall be not less than 50 D^3, where D is the declared coarsest fraction of the aggregate in mm.

Normally, the entire specimen as received shall be used for the determination. If the shape or size of a specimen is such that it is not possible to use all of it, a smaller specimen may be broken or sawn from the original.

Capped specimens shall not be used.

6 Procedures

6.1 General

6.1.1 Determination of mass

This European Standard recognizes three conditions under which the mass of a specimen can be determined:

a) as-received;

b) water saturated;

c) oven-dried.

6.1.2 Determination of volume

This European Standard recognizes three methods for determining the volume of the specimen:

a) by water displacement (reference method);

b) by calculation using actual measurements;

c) for cubes, by calculation, using checked, designated dimensions.

NOTE 1 The precision of the method depends on the method selected for measuring the volume of the specimen. Measurement of volume by the water-displacement method is the most precise, followed by calculation using measurement of actual dimensions and lastly calculation using checked, designated dimensions.

NOTE 2 The limitation to cubes in 6.1.2 c) of using designated dimensions in calculation of volume is due to the greater tolerance on length, according to EN 12390–1, of other specimen shapes.

6.2 Mass of as-received specimen

Weigh the as-received specimen m_r, to a maximum permissible error of 1 g of the mass of the specimen. Record the value indicated in kg.

6.3 Mass of water saturated specimen

Immerse the specimen in water at (20 ± 2) °C until the mass changes by less than 0,2 % in 24 h, wiping the surplus water from the surface before each weighing. Record the value of the saturated mass m_s, in kg.

Specimens of concrete cured in water for at least 72 h prior to testing, may be assumed to be saturated to a constant mass.

6.4 Mass of oven-dried specimen

Dry the specimen in a ventilated oven at (105 ± 5) °C until the mass changes by less than 0,2 % in 24 h. Before each weighing, cool the specimen to near room temperature in a dry airtight vessel or desiccator. Record the value of the oven-dried mass m_0 as indicated, in kg.

6.5 Volume obtained by water displacement

6.5.1 General

Ensure that the specimen is a saturated condition.

This method is suitable for specimens of all shapes and is the only method suitable for specimens of irregular shape.

This method is normally unsuitable for specimens of no-fines concrete, lightweight aggregate concrete with large pores, or specimens whose moisture content must not be altered. However, the application of a thin water impermeable layer can make this method practicable.

6.5.2 Mass in water

Determine the mass of the specimen in water according to the following procedure:

Raise the water tank until the stirrup, without a specimen, is immersed in the water tank and does not touch the bottom of the tank. Record the apparent mass of the stirrup m_{st}, in kg.

The apparent mass of the stirrup may alternatively be allowed for using a zero setting facility on the balance (tareing).

Place the specimen in the stirrup and raise the water tank until the specimen is submerged and the water level on the stirrup is the same as it was without the specimen.

Trapping of air bubbles on the sides of the specimen and on the stirrup should be avoided.

Record the apparent mass (m_{st} + m_w), in kg, of the immersed specimen and stirrup.

6.5.3 Mass in air

Determine the mass of the specimen in air according to the following procedure:

Remove the specimen from the stirrup and wipe the surplus water from the surfaces, using a damp cloth. Place the specimen on the balance and record the mass of the specimen in air m_a in kg.

6.5.4 Calculate the volume of the specimen

Calculate the volume of the specimen, using Formula (1):

$$V = \frac{m_a - \left[\left(m_{st} + m_w\right) - m_{st}\right]}{\rho_w} \qquad (1)$$

where

V is the volume of the specimen, in m^3;

m_a is the mass of the specimen in air, in kg;

m_{st} is the apparent mass of the immersed stirrup, in kg;

m_w is the apparent mass of the immersed specimen, in kg;

ρ_w is the density of water, at 20 °C, taken as 998 kg/m^3.

6.6 Volume obtained by measurement

Calculate the volume of the specimen from measurements made on the specimen in accordance with EN 12390-1, in m^3, rounded to four significant figures.

6.7 Volume obtained by using designated dimensions (cubes only)

Confirm that the cube has been made in a calibrated mould, conforming to EN 12390-1. Check the dimensions in accordance with EN 12390-1.

Calculate the volume of the cube in m^3, expressed to 3 significant figures.

7 Test result

Calculate the density using the values determined for the mass of specimen and its volume, using Formula (2):

$$D = \frac{m}{V} \tag{2}$$

where

D is the density related to the condition of the specimen and the method of determining the volume, in kg/m^3;

m is the mass of the specimen as determined in 6.2, 6.3 or 6.4 at the time of test, in kg;

V is the volume determined by the particular method, in m^3.

Report the condition of the specimen at the time of test and the method used for determining the volume of the specimen as part of the test result.

Express the result of the density determination to the nearest 10 kg/m^3.

8 Test report

The report shall include:

a) reference to this standard;

b) identification of the test specimen;

c) location of performance of test;

d) description of the specimen (e.g. 100 mm cube, 150 mm diameter core);

e) details of specimen preparation (if any);

f) condition of specimen at time of test; (as-received, or water saturated, or oven-dried);

g) method of determination of volume; (water displacement, or measured size, or checked, designated size);

h) date of test;

i) calculated density of specimen, in kg/m^3;

j) any deviation from the standard test method;

k) a declaration by the person technically responsible for the test that it was carried out in accordance with this document, except as noted in item j).

9 Precision

Precision data are given in Table 1. These apply to density measurements in the range 2 300 kg/m^3 to 2 400 kg/m^3 on cubes made from the same sample of concrete and when each test result is obtained from a single determination of the saturated density of a single cube. They indicate the variability that occurs when sampling, making and curing the cubes.

Table 1 — Precision data for measurements of the saturated density of hardened concrete

Test method	**Repeatability conditions**		**Reproducibility conditions**	
	s_r kg/m^3	r kg/m^3	s_R kg/m^3	R kg/m^3
By calculation using measured dimensions:				
100 mm cubes	13,9	39	20,5	57
150 mm cubes	9,9	28	20,5	57
By water displacement:				
100 mm cubes	6,5	18	12,8	36
150 mm cubes	6,4	18	10,6	30

NOTE 1 The precision data were determined as part of an experiment carried out in 1987 in which precision data were obtained for several of the tests described in BS 1881 [2]. The experiment involved 16 operators. The concretes were made using an ordinary Portland cement, Thames Valley sand, and Thames Valley 10 mm and 20 mm coarse aggregates.

NOTE 2 The difference between two test results from the same sample by one operator using the same apparatus within the shortest feasible time interval will exceed the repeatability value *r* on average not more than once in 20 cases in the normal and correct operation of the method.

NOTE 3 Test results on the same sample obtained within the shortest feasible time interval by two operators each using their own apparatus will differ by the reproducibility value *R* on average not more than once in 20 cases in the normal and correct operation of the method.

NOTE 4 For further information on precision, and for definitions of the statistical terms used in connection with precision, see ISO 5725-1 [1].

Bibliography

[1] ISO 5725-1, *Accuracy (trueness and precision) of measurement methods and results — Part 1: General principles and definitions*

[2] Series BS 1881, *Testing concrete*

NO COPYING WITHOUT BSI PERMISSION EXCEPT AS PERMITTED BY COPYRIGHT LAW

British Standards Institution (BSI)

BSI is the national body responsible for preparing British Standards and other standards-related publications, information and services.

BSI is incorporated by Royal Charter. British Standards and other standardization products are published by BSI Standards Limited.

About us

We bring together business, industry, government, consumers, innovators and others to shape their combined experience and expertise into standards -based solutions.

The knowledge embodied in our standards has been carefully assembled in a dependable format and refined through our open consultation process. Organizations of all sizes and across all sectors choose standards to help them achieve their goals.

Information on standards

We can provide you with the knowledge that your organization needs to succeed. Find out more about British Standards by visiting our website at bsigroup.com/standards or contacting our Customer Services team or Knowledge Centre.

Buying standards

You can buy and download PDF versions of BSI publications, including British and adopted European and international standards, through our website at bsigroup.com/shop, where hard copies can also be purchased.

If you need international and foreign standards from other Standards Development Organizations, hard copies can be ordered from our Customer Services team.

Copyright in BSI publications

All the content in BSI publications, including British Standards, is the property of and copyrighted by BSI or some person or entity that owns copyright in the information used (such as the international standardization bodies) and has formally licensed such information to BSI for commercial publication and use.

Save for the provisions below, you may not transfer, share or disseminate any portion of the standard to any other person. You may not adapt, distribute, commercially exploit or publicly display the standard or any portion thereof in any manner whatsoever without BSI's prior written consent.

Storing and using standards

Standards purchased in soft copy format:

- A British Standard purchased in soft copy format is licensed to a sole named user for personal or internal company use only.
- The standard may be stored on more than one device provided that it is accessible by the sole named user only and that only one copy is accessed at any one time.
- A single paper copy may be printed for personal or internal company use only.

Standards purchased in hard copy format:

- A British Standard purchased in hard copy format is for personal or internal company use only.
- It may not be further reproduced – in any format – to create an additional copy. This includes scanning of the document.

If you need more than one copy of the document, or if you wish to share the document on an internal network, you can save money by choosing a subscription product (see 'Subscriptions').

Reproducing extracts

For permission to reproduce content from BSI publications contact the BSI Copyright and Licensing team.

Subscriptions

Our range of subscription services are designed to make using standards easier for you. For further information on our subscription products go to bsigroup.com/subscriptions.

With **British Standards Online (BSOL)** you'll have instant access to over 55,000 British and adopted European and international standards from your desktop. It's available 24/7 and is refreshed daily so you'll always be up to date.

You can keep in touch with standards developments and receive substantial discounts on the purchase price of standards, both in single copy and subscription format, by becoming a **BSI Subscribing Member.**

PLUS is an updating service exclusive to BSI Subscribing Members. You will automatically receive the latest hard copy of your standards when they're revised or replaced.

To find out more about becoming a BSI Subscribing Member and the benefits of membership, please visit bsigroup.com/shop.

With a **Multi-User Network Licence (MUNL)** you are able to host standards publications on your intranet. Licences can cover as few or as many users as you wish. With updates supplied as soon as they're available, you can be sure your documentation is current. For further information, email cservices@bsigroup.com.

Revisions

Our British Standards and other publications are updated by amendment or revision.

We continually improve the quality of our products and services to benefit your business. If you find an inaccuracy or ambiguity within a British Standard or other BSI publication please inform the Knowledge Centre.

Useful Contacts

Customer Relations
Tel: +44 345 086 9001
Email: cservices@bsigroup.com

Subscription Support
Tel: +44 345 086 9001
Email: subscription.support@bsigroup.com

Knowledge Centre
Tel: +44 20 8996 7004
Email: knowledgecentre@bsigroup.com

Copyright and Licensing
Tel: +44 20 8996 7070
Email: copyright@bsigroup.com

BSI Group Headquarters

389 Chiswick High Road London W4 4AL UK